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Cogeneration Case Study

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NADC, Ames, IA Cogen Project Case Study

- **National Animal Disease Center**
  Mission Critical Research
  40 Year-old Boiler Plant Needing Replacement ($5M)
  Year-round Process and HVAC Steam Loads
  Blended Electric Cost = $.055/Kwh

- **1.2 MW Gas Turbine/Generator**

- **Heat Recovery Steam Generator w/supplemental firing**
  - **8,300 #/hr "free" steam capacity**
  - **35,000 #/hr duct fired steam capacity**

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Why Cogeneration?

The Ideal Project Profile

- ✓ Electrical Blended Cost > $.05/kwh
- ✓ Simultaneous and Balanced Electrical/Thermal Load (large health care, industrial, campus setting)
- ✓ Concern over electrical de-regulation and reliability of service
- ✓ Aging power plant (boilers, chillers)
- ◆ Need additional power plant capacity
- ◆ De-regulated electrical state
- ✓ Limited capital project funds available

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Cogeneration ECM

-1.2 MW Combustion Turbine
-Dual-fuel capability
-Base load design

-Replace 40yr old boiler
-Heat Recovery Boiler
-8,300 #/hr + 27,000 #/hr ductfire = 35,300 #/hr

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System Design Selection

- **Average Thermal/Electrical Load Ratio Typical of Gas Turbine/HRSG System**
- **Average Load Profiles Led To Base-Loaded Operation**
- **Highly Variable Steam Loads Good Application for Duct Firing**

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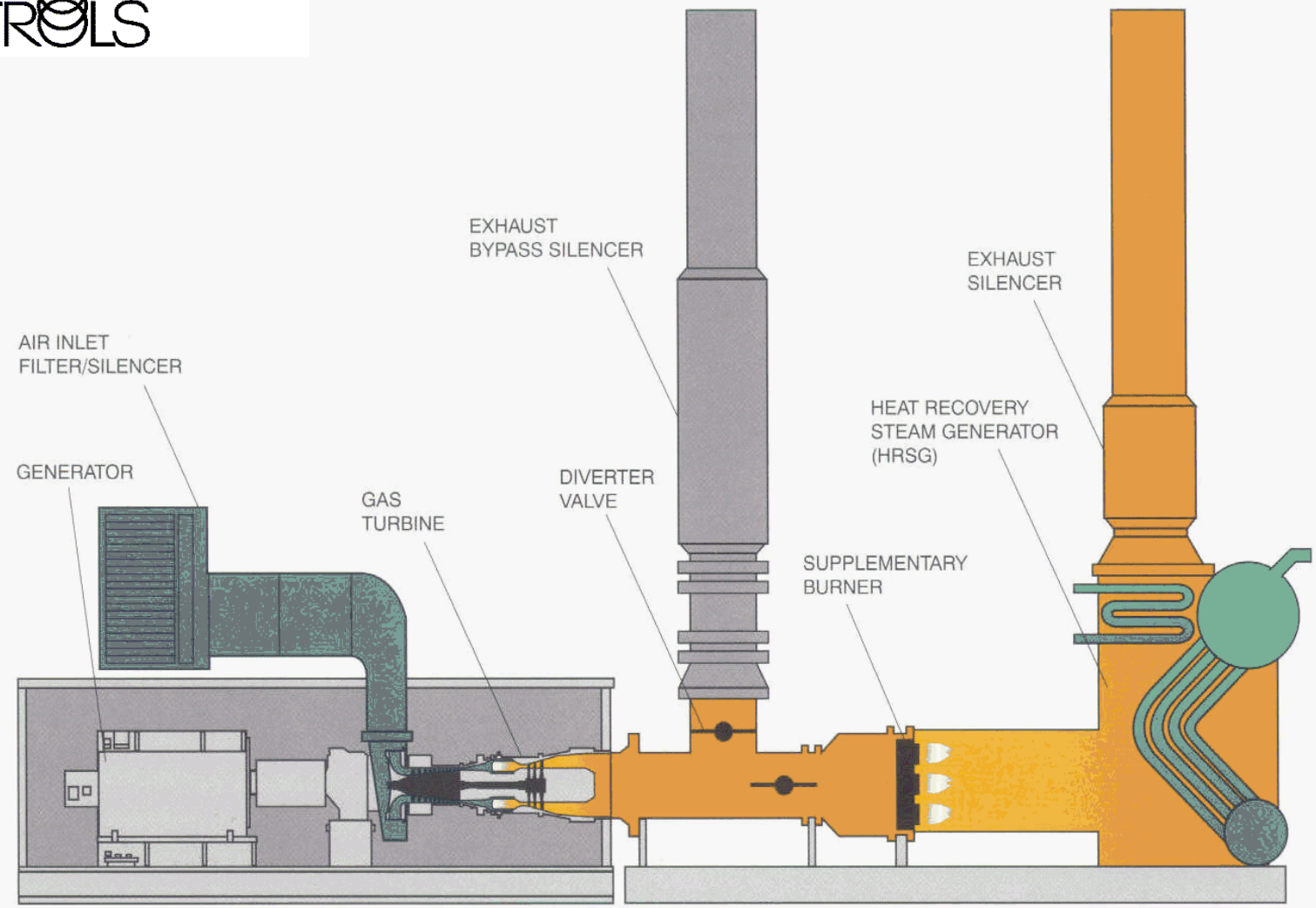

Solar® Turbines

A Caterpillar Company

Cogeneration System

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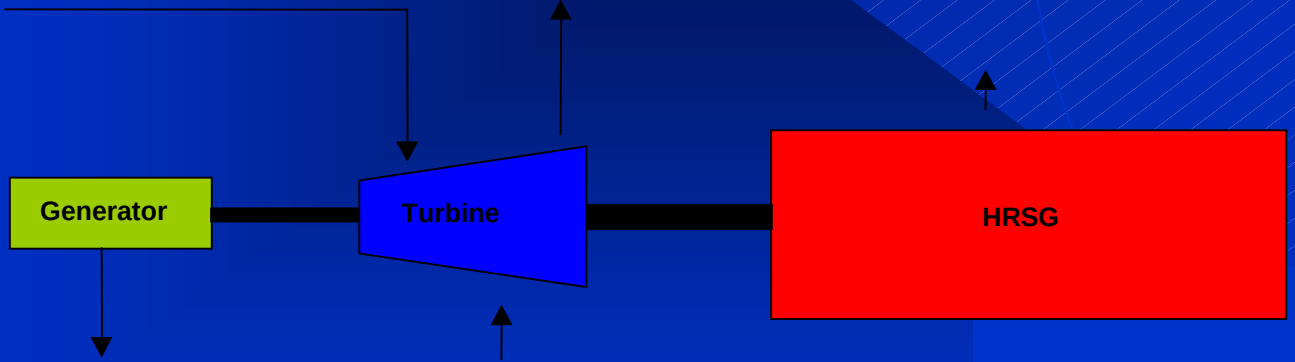
Ideal Base-Loaded Generation Economics

Inputs	Existing Steam Generation Efficiency %	Produced Steam Cost $/MMBtu	Purchased Steam Cost $/MMBtu	Electric Cost $/kwh Blended	Excess Power Utility Purchase Contract $/kwh	Cogen System Efficiency %	Turbine Efficiency % Fuel to Electric	Turbine Maintenance Cost $/KWH
Gas Cost $/MMBtu								
$ 2.80	80%	$ 3.50		$ 0.050	$ -	72%	27%	$ 0.003

Fuel Input
1,000,000 Btu
$ 2.80

System Loss
280,000 Btu
$ 0.78

Steam Produced
450,000 Btu
$ 1.58 used as existing thermal load



Electric **Generated**
270,000 Btu Elec.
79.1 KWH
$ 3.96 used to replace existing electric purchase

Maintenance
$ 0.24

Net FB Cost/KWH
$ 0.018

Net FB Cost = (Fuel Cost + Maint Cost - Value of Free Steam)/KWH Generated

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NADC Generation Economics

- Cost of Purchased Electrical = $.055 / KWH
- Fully-Burdened Net Cost of Generation = (Cost of Gas + Cost of Maintenance - Value of Free Recovered Steam) / KWH Generated

  $.021 / KWH
- Additional Duct Firing Savings
  - Old Avg Steam Generation Efficiency = 70%
  - New Avg Duct Fired Steam Efficiency > 92%

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Project Costs / Economics

- **Cogen System Project Cost = $ 3.1M (over $2,500 / KW installed)**
- **Annual Savings = $334,609 (including maintenance required)**
- **SPB = 9.3 yrs, + Avoided Cost of Boiler Replacement**
- **Explore Utility Incentives or Rebates**

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Other Potential Project Barriers

- **Customer Perception**
- **Local Utility Interconnection**
- **Environmental Permitting Issues**
- **High Development Costs (must have commitment!)**

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Maintenance/Service Requirements

- **Don’t Forget About Maintenance!**
- **Traditional PMs Rotating Machines/Boilers**
- **4X Per Year Factory Service**
- **3-5 Year Combustion Turbine Overhaul**

$.004 / KWH for Turbine

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Cogen Project Case Study #2

- **Mercy Hospital, Cedar Rapids, IA (Discovery Phase)**

  Functionally "Spent" Chiller Plant, District Steam Use
  Year-round Process and HVAC Steam Loads
  Blended Electric Cost = $.055/Kwh

  - **3.5 MW Gas Turbine/Generator**
  - **Currently paying $5.75/Mlb District Steam Loop**
  - **Absorption Chillers past useful life (need new chillers)**
  - **Currently Expanding Hospital**
  - **Extremely Limited Capital**
  - **$6 M project funded from savings, frees capital for revenue generating expansion**

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Cogen Project Case Study #3

- **San Diego, Marine Corps Facility (Discovery Phase)**

  Deregulated Electric State
  Sprawling Military Base
  One failed de-regulated utility contract
  One gas company cogen project proposal (non-guaranteed)
  Blended Electric Cost = $.115/Kwh

  - **5 MW Gas Turbine/Generator w/ HRSG**
  - **Replace Existing Chillers with Absorbers**
  - **Estimated Project Cost = $ 15 M, Annual Savings = $4,000,000**
    SPB= 3.75 yrs

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Is Cogeneration Right For You?

- ✓ **Compare Facility Needs With Typical Cogen Profile**
- ✓ **Evaluate Thermal / Electrical Load Profiles**
- ✓ **Generation Economics (Don't forget about maintenance!)**
- ✓ **Understand Local Utility and Environmental Issues and Get Others Involved Early**
- ✓ **Select the Right Partners For You**